Agenda Item E.6.a
Attachment 7
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Status of the widow rockfish resource in 2007
An Update

(Draft)

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Executive Summary

Stock: This assessment applies to widow rockfish (*Sebastes entomelas*) located in the territorial waters of the U.S., including the Vancouver, Columbia, Eureka, Monterey, and Conception areas designated by the International North Pacific Fishery Commission (INPFC). The stock is assumed to be a single mixed stock and subject to four major fisheries (see figure below).

Catches: The earliest records of foreign landings of widow rockfish were in 1966. U.S. catches of widow rockfish began in 1973, peaking in 1981. Since the 1981 peak there has been a steady decline in the landings of widow rockfish to 28 mt in 2003 and to 70 mt in 2006 (2006 catch estimates are preliminary). Catches were mostly from commercial fisheries. Catches from recreational fisheries ranged from less than 2 mt in 2003 to 375 mt in 1982. The dominant gear type historically has been the midwater trawl. During the early 1990s, bottom trawl catches nearly matched the midwater trawl catches.

Table E1. Recent landings (mt) of widow rockfish by four fisheries from 1990 to 2006.

Year	Vancouver, Columbia	Oregon Midwater Trawl	Oregon Bottom Trawl	Eureka, Monterey, and Conception	Total
1990	2241	3214	2167	2652	10274
1991	1176	1816	1935	1375	6301
1992	946	1149	2632	1324	6052
1993	1747	1755	3386	1348	8236
1994	1074	1678	2382	1248	6384
1995	1087	1394	2295	1926	6703
1996	965	1464	2137	1528	6094
1997	1016	1523	2245	1707	6492
1998	563	759	1330	1304	3956
1999	525	1721	796	901	3943
2000	380	2276	16	1141	3814
2001	302	966	39	505	1812
2002	65	155	6	51	276
2003	16	8	0	5	28
2004	31	12	2	28	74
2005	43	59	1	10	113
2006	46	11	2	11	70

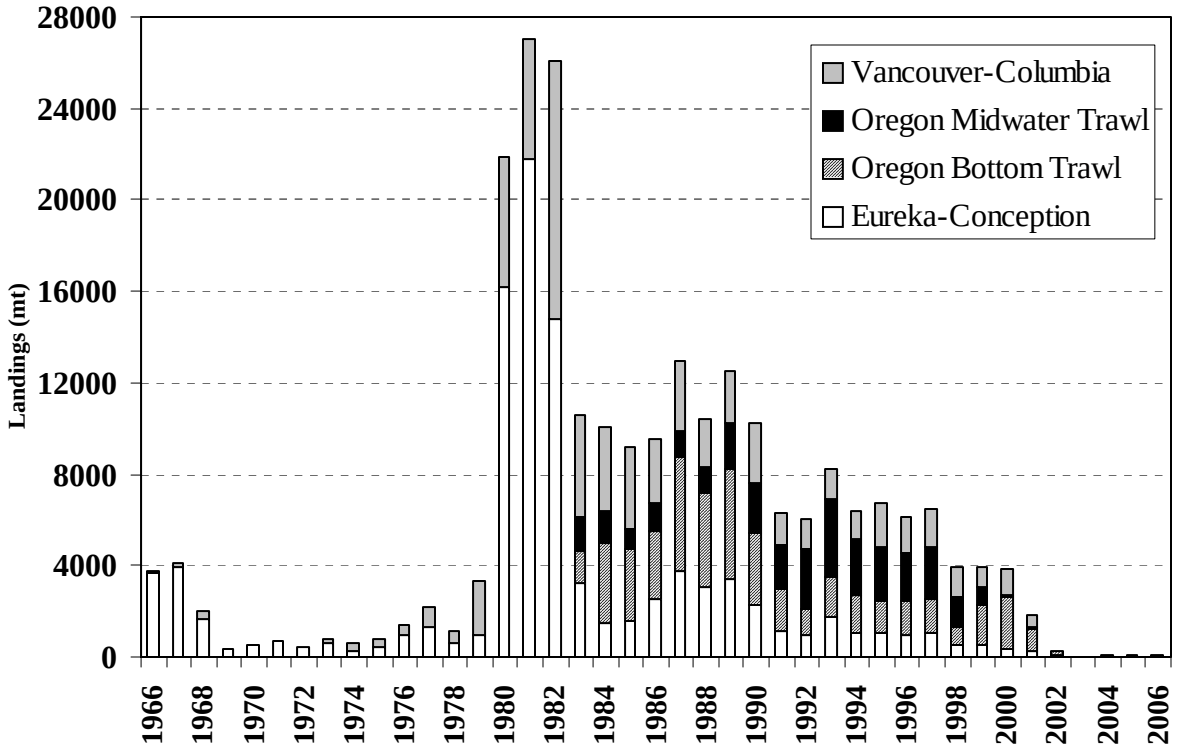


Figure E1. Total landings of widow rockfish from 1966 to 2006

Data and assessment: The last assessment of widow rockfish was conducted in 2005 using an age-based population model (written in ADMB, He et al. 2006). All fishery data, including landings, age composition, and logbook catch rates, were recently downloaded from the PacFIN, CALCOM, and NORPAC databases, or provided by state agencies. Since this assessment is an update assessment, the same assessment model and data compiling procedures were used in this assessment. New data from 2005 and 2006, including catches, age composition, and CPUE time series, were included in this assessment.

Unresolved problems and major uncertainties:

1. The primary source of information on trends in abundance of widow rockfish comes from the Oregon bottom trawl logbook data, which is a questionable source of information for widow rockfish. In addition, no information after 1999 in the Oregon bottom trawl logbook data can be used in the assessment because the catch rates were very low due to trip limits and other management regulations. Based on a recommendation by the 2003 STAR panel, triennial survey indices have been used in this assessment as an additional abundance index.
2. Natural mortality was fixed at 0.15 in previous assessments. The 2005 STAR panel recommended natural mortality to be fixed at 0.125, but the validity of this estimate is still uncertain.
3. There exist uncertainties in estimating stock-recruitment relationships. Similar to other rockfish species in the area, the biomass of widow rockfish has decreased steadily since the early 1980s and recruitment during early 1990s is estimated to have been

considerably smaller than before the mid 1970s. The reason for the lower recruitment during the period could be due to lower spawning stock biomass, but it could also be due to a lower productivity regime. However, there is evidence that recruitment of many rockfish species since 1999 has been higher than the average of the 1990s. This is also supported by the most recent juvenile survey data and age composition data.

4. The uncertainties in stock-recruitment relationship would lead to greater uncertainties in the rebuilding analysis because it largely depends on how future recruitments are generated.
5. There was considerable discussion about the appropriate use of the Santa Cruz juvenile survey data in the 2003 and 2005 STAR Panel reviews. It was noted that the survey indices are highly variable, that the index has not always identified strong year-classes, and that power transformation of this index has some influences on the results. It has been suggested that the area coverage of the Santa Cruz juvenile survey might not be sufficient to monitor coast-wide distribution of widow rockfish and oceanographic conditions. The Pre-recruit Survey Workshop held in September 2006 suggested using only coast-wide pre-recruit survey indices, which are only available from 2001 to 2006. Since the assessment model uses 3 to 20+ age groups, only pre-recruit data from 2001 to 2003 can be used in the assessment model. It is a very short time series data. Nevertheless, a model run with only 2001-2006 coast-wide pre-recruit survey indices is included for reference (Appendix B).
6. Stock structure issues, in particular the relationship to the Canadian stock, remain an important source of uncertainty.

Reference points: The percentage ratio of spawning output in 2006 to unfished spawning output (B_0) is the population status ("depletion rate"). A depletion rate below 25% indicates an overfished stock, and depletion rates between 25% and 40% indicate a precautionary zone. A depletion rate over 40% is a healthy stock. The following reference points were obtained from the assessment model:

Table E2. Estimated reference points from the assessment.

Quantity	Value
Unfished spawning output (B_0)(millions of eggs)	50434
Current spawning output (B_t) (millions of eggs)	18253
Depletion rate ($100*B_t/B_0$)	36.19
Spawning output at MSY (B_{msy}) (millions of eggs)	20174
Basis for B_{msy}	$B_{40\% proxy}$
F_{msy}	0.1204
Basis for F_{msy}	$F_{50\% proxy}$

Stock biomass: Stock biomass has shown a steady decline between 1977 and 2000, soon after the fisheries for widow rockfish began. Since 2001, stock biomass has shown an increasing trend. The following table and figure show time series of estimated catches, discards, stock biomass, fishing mortality, and recruitments from the assessment model.

Table E3. Estimated biomass, recruitment, discard, and other annual parameters from the stock assessment from 1990 to 2006.

Year	Total biomass (mt)	Spawning biomass (mt)	Recruitment (*1000)	Landing (mt)	Discard (mt)	Fishing Mortality	Exploitation rate	Depletion (%)
1990	142592	64146	24392	10266	1955	0.1792	0.1593	49.0
1991	131250	59804	15815	6305	1201	0.1185	0.1080	46.4
1992	124337	57274	15831	6055	1153	0.1225	0.1139	44.8
1993	121627	54294	29367	8223	1566	0.1875	0.1691	42.8
1994	121884	50045	44745	6365	1212	0.1605	0.1450	39.5
1995	117194	47413	13786	6684	1273	0.1794	0.1652	37.2
1996	112361	45594	15639	6079	1158	0.1663	0.1520	35.2
1997	107001	45345	13476	6475	1233	0.1601	0.1466	34.5
1998	99128	44928	7464	3956	754	0.0930	0.0875	34.3
1999	94005	44712	7687	3948	752	0.1023	0.0915	34.5
2000	89023	43250	9908	3824	728	0.1099	0.0955	33.9
2001	87315	41083	22708	1814	346	0.0568	0.0505	32.7
2002	88329	39770	18260	276	53	0.0096	0.0084	31.9
2003	105387	39801	67067	28	5	0.0010	0.0009	31.8
2004	111365	40759	16013	74	14	0.0022	0.0022	32.1
2005	116772	43782	17196	113	22	0.0033	0.0029	33.4
2006	120989	48370	16395	70	13	0.0014	0.0014	36.2

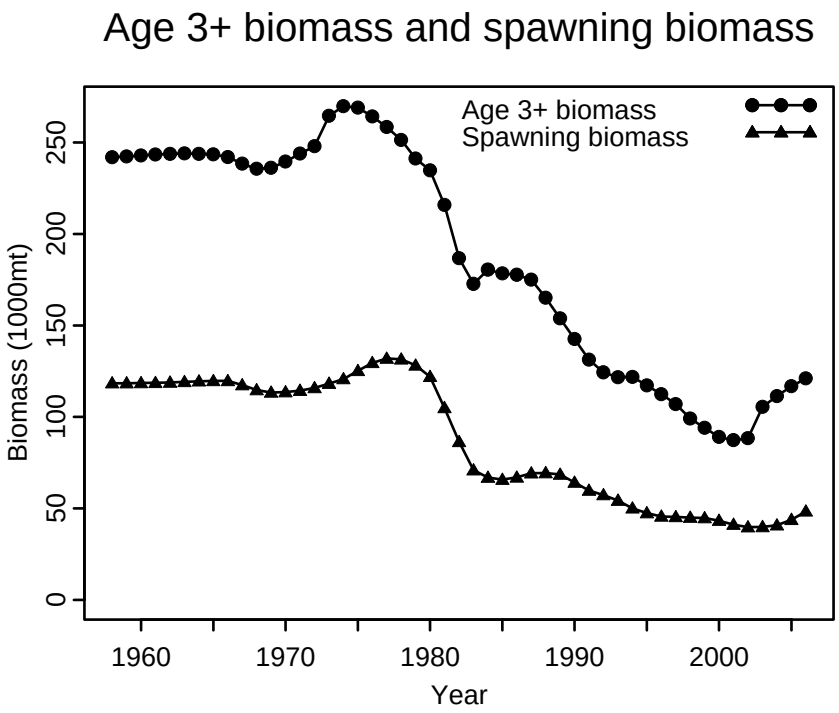


Figure E2. Age 3+ biomass (1000mt) and spawning biomass (1000mt) from 1958 to 2006 estimated from the assessment model.

Recruitment: The model estimated time series of recruitment of age 3 fish from 1958 to 2001. The highest recruitment occurred in 1972. Recruitments remained generally low in the early 1990s as compared to the long-term average, but showed an increasing trend in recent years. The following figure shows that recruitment of age 3 in 2003 (born in 2000) is relatively high. This relative strong recruitment class is one of main reasons that the current spawning biomass is higher than that in the 2005 assessment. However, there are uncertainties about how strong this recruitment class really is. One reason is that we have small ageing samples from the most recent years to better measure this recruitment class.

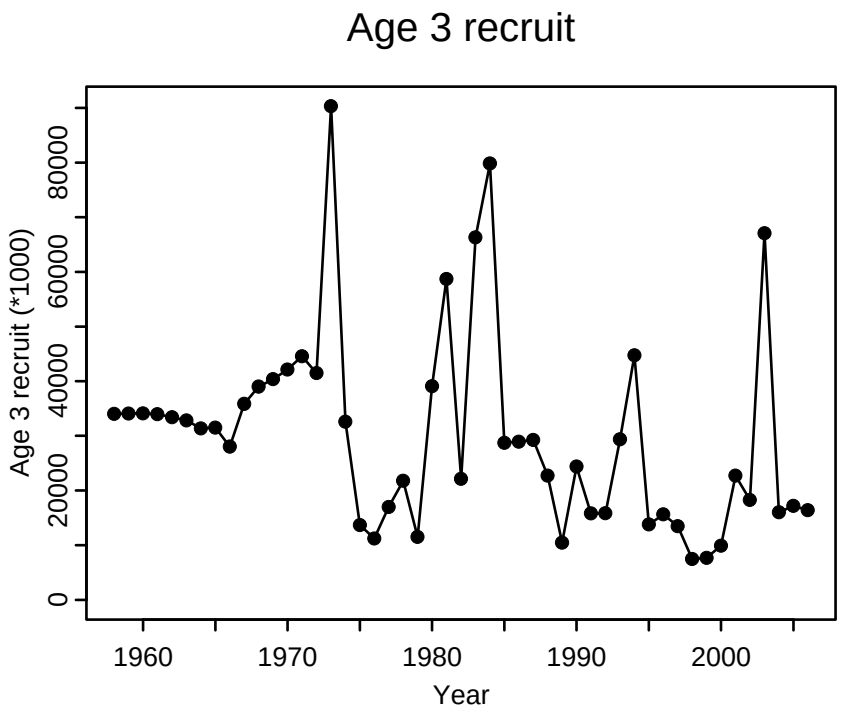


Figure E3. Age 3 recruits (*1000) from 1958 to 2006 estimates from the assessment model.

Exploitation status: The point estimate of the current spawning output is at 36.2% of the unfished level (see table above).

Management Performance: See below.

Table E4. Management performance from 1989 to 2007.

Year	Harvest Guideline	Allowable Biological Catch	Landings
1989	12100	12400	12486
1990	12400	8900	10274
1991	7000	7000	6301
1992	7000	7000	6052
1993	7000	7000	8236
1994	6500	6500	6384
1995	6500	7700	6703
1996	6500	7700	6094
1997	6500	7700	6492
1998	5090	5750	3956
1999	5090	5750	3943
2000	5090	5750	3814
2001	2300	3727	1812
2002	856	3727	276
2003	832	3871	28
2004	284	3460	74
2005	285	3218	113
2006	289	3059	70
2007	368	5334	

Forecasts: The estimated current depletion rate is 36.1% of unfished (virgin) spawning output with 95% confidence level ranged from 23.53% to 48.85. It is estimated that the population will recover to the target (40% of unfished spawning output) in 2009. Forecasts of future biomass at five constant catch levels (ranged from 500mt to 4000mt each year) are presented in the following tables and figures. They show that the biomass will not fall below the target biomass (40% of unfishing level) if future catches remain at or below 2000mt per year.

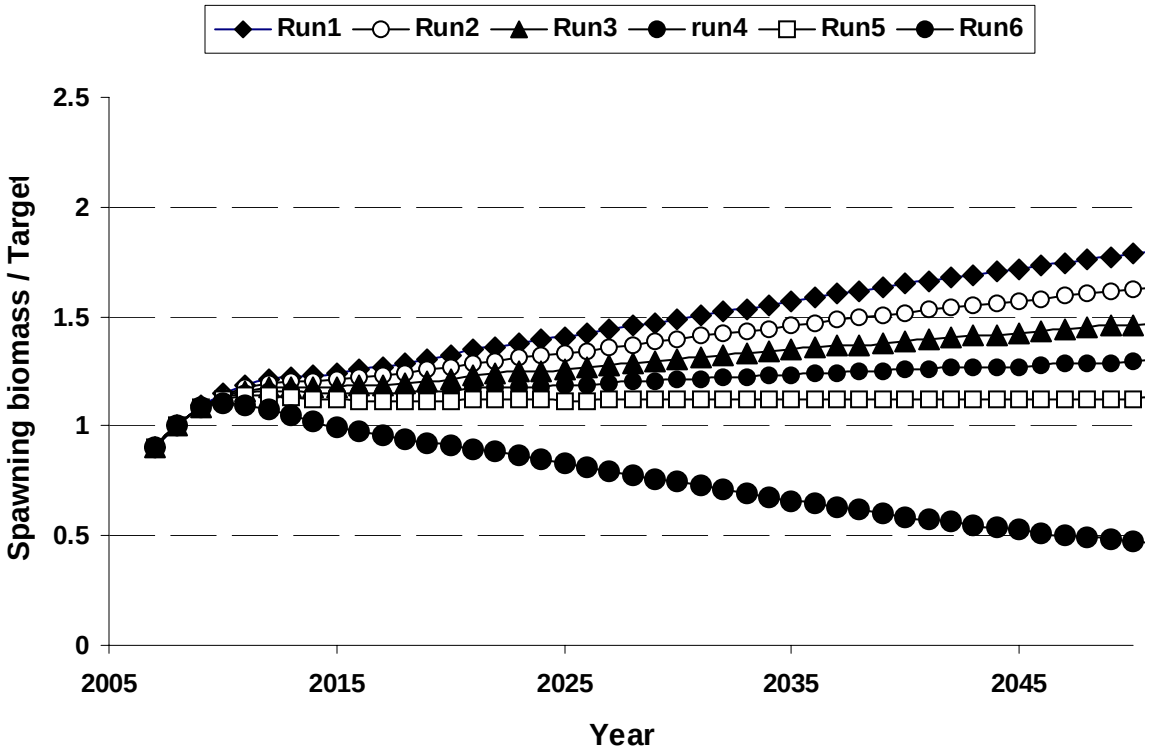
Table E5. Specifications of six rebuilding simulation runs based on different annual catch for future years. Future recruitments are generated using the stock-recruitment relationship estimated in the stock assessment. Maximum fishing mortalities for all future years are set to *Fmsy*.

Run name	Start Year	Catch time series
Run1	2007	368 mt of catch in 2007, and then no catch thereafter
Run2	2007	368 mt of catches in 2007 and 2008, 500 mt thereafter
Run3	2007	368 mt of catches in 2007 and 2008, 1000 mt thereafter
Run4	2007	368 mt of catches in 2007 and 2008, 1500 mt thereafter
Run5	2007	368 mt of catches in 2007 and 2008, 2000 mt thereafter
Run6	2007	368 mt of catches in 2007 and 2008, 4000 mt thereafter

Table E6. Proposed future catches (mt) and estimated exploitable biomass (mt) for six rebuilding runs from 2009 to 2018. The estimated target exploitable biomass is about 26,668 mt, which is roughly corresponding to 40% of virgin spawning output. The population is estimated to recover in 2009. SPR rates and fishing mortalities are average values from 2007 to 2018.

	Run1		Run2		Run3		Run4		Run5		Run6	
Probability of recovery	1.0		1.0		1.0		1.0		1.0		1.0	
Recovery time	2009		2009		2009		2009		2009		2009	
SPR rate	1.000		0.9417		0.8853		0.8307		0.7780		0.6168	
Fishing mortality	0.0000		0.0084		0.0171		0.0263		0.0358		0.0791	
	Catch	Biomass	Catch	Biomass	Catch	Biomass	Catch	Biomass	Catch	Biomass	Catch	Biomass
2009	0	68148	500	67656	1000	67454	1500	67253	2000	67049	4000	66231
2010	0	66767	500	65947	1000	65383	1500	64826	2000	64252	4000	61991
2011	0	64220	500	63145	1000	62287	1500	61477	2000	60571	4000	57142
2012	0	61557	500	60294	1000	59212	1500	58133	2000	57048	4000	52717
2013	0	59533	500	58128	1000	56871	1500	55676	2000	54370	4000	49353
2014	0	58344	500	56848	1000	55454	1500	54147	2000	52672	4000	47106
2015	0	57945	500	56352	1000	54869	1500	53440	2000	51885	4000	45847
2016	0	58175	500	56488	1000	54896	1500	53130	2000	51686	4000	45179
2017	0	58784	500	56968	1000	55251	1500	53273	2000	51792	4000	44731
2018	0	59369	500	57415	1000	55558	1500	53501	2000	51815	4000	44145

Figure E4. Time series of spawning biomass over target for proposed six simulation runs. Note that only Run6 (annual catch of 4000mt) results in the spawning biomass fell below the target level (spawning biomass over target equals to 1).



Recommendations:

1. There are increasingly fewer reliable abundance indices for widow rockfish. Recent management measures have undermined the ability to continue fishery dependent time series of relative abundance from the Oregon bottom trawl fishery and Pacific whiting fishery since 1999. The constant flux of the management regime suggests that there is little likelihood that meaningful CPUE indices can be developed from these fisheries in the future. More analysis should be done to either calibrate or compare triennial survey results with those from the NWFSC Combined survey.
2. Long-term recruitment index is a key datum series in the stock assessment. Continuation of the midwater juvenile trawl survey and recent increases in sampling intensity and spatial coverage will improve estimation confidence and data quality. Comparison and possibly integration of the existing juvenile survey results with a recently initiated survey by the fishing industry (See Report on Pre-recruit Survey Workshop, September 2006) could also broaden the spatial extent of this index. The ability to infer direct and indirect estimates of year class strengths from surveys and other sources, as well as to better understand the relationship between environmental conditions in the California Current

System, should improve short-term forecasts of productivity, biomass levels and allowable catches from stock assessments.

3. Preliminary information from recent bycatch monitoring suggest that discards may have decreased substantially compared to the assumed 16% currently used. New discard data should be analysed and, if warranted, past discard estimates should be adjusted.
4. The utility of hydro-acoustic surveys on widow rockfish abundance should be evaluated in future assessments.
5. Sample sizes for existing age-collection programs (by fishery and survey) should be increased substantially.
6. The age-composition for the triennial survey should be determined by applying year-specific age-length keys to the survey length-frequencies, and included in future assessments as a basis for estimating survey selectivity.